NATIONAL ENGINEERING HANDBOOK

SECTION 4

HYDROLOGY

CHAPTER 7. HYDROLOGIC SOIL GROUPS

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CHAPTER 7--HYDROLOGIC SOIL GROUP

CONTENTS

CHAPTER 7. HYDROLOGIC SOIL GROUPS

This chapter gives definitions of four soil groups that are used in determining hydrologic soil-cover complexes (chap. 9), which are used in a method for estimating runoff from rainfall (chap. 10). A table gives the group-classifications of more than 4,000 soils in the United States and Puerto Rico. Methods of making and using the classifications are briefly discussed.

Watershed-Soils Classification

Soil properties influence the process of generation of runoff from rainfall and they must be considered, even if only indirectly, in methods of runoff estimation. When runoff from individual storms is the major concern, as in flood prevention work, the properties can be represented by a hydrologic parameter: <u>the minimum rate of infiltration obtained for a bare soil after prolonged wetting</u>. The influences of both the surface and the horizons of a soil are thereby included. The influence of ground cover is treated independently, as discussed in chapters 8, 9, and 10.

The parameter, which indicates the runoff potential of a soil, is the qualitative basis of the classification in this chapter of all soils into four groups. The classification is broad but the groups can be divided into subgroups, as shown in example 7.1, whenever such a refinement is justified. Chapter 9 describes how the groups are given quantitative significance in the runoff-estimation method of chapter 10.

DEFINITIONS

In the definitions to follow, the <u>infiltration rate</u> is the rate at which water enters the soil at the surface and which is controlled by surface conditions, and the <u>transmission rate</u> is the rate at which the water moves in the soil and which is controlled by the horizons. The hydrologic soil groups, as defined by SCS soil scientists, are:

A. (Low runoff potential). Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well to excessively drained sands or gravels. These soils have a high rate of water transmission.

B. Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

C. Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.

D. (High runoff potential). Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

The Soil List

The list at the end of this chapter contains the names of more than 4,000 soils in the United States and Puerto Rico. The capital letter following a name designates the hydrologic soil group classification.

The original classifications were based on the use of rainfall-runoff data from small watersheds or infiltrometer plots, but the majority are based on the judgments of soil scientists and correlators who used physical properties of the soil in making their decisions. They classified a soil in a particular group by comparing its profile with profiles of soils already classified. They assumed that the soil surfaces were bare, maximum swelling had taken place, and rainfall rates exceeded surface intake rates. Thus, most of the classifications are based on the premise that similar soils (similar in depth, organic-matter content, structure, and degree of swelling when saturated) will respond in an essentially similar manner during a rainstorm having excessive intensities.

The classification of a soil in the list can be checked by using the procedure of example 5.4. The soil in question must be the only one on the watershed and rainfall-runoff data for bare-soil periods must be available. Checks that have been made so far have not caused any changes in the present classification.

USE OF THE SOIL GROUPS

To use the soil list it is necessary to know only the names of the soils on the watershed being studied. To use the classification in estimating runoff (chap. 10) it is also necessary to know the area of each soil and, if the watershed is large, its location by hydrologic units (chap. 6). The SCS hydrologist usually consults a State soil scientist when soils of a watershed are to be classified. If there is no soil survey for the watershed the consultant can usually get adequate information from work unit personnel. Making a soil survey solely for hydrologic purposes is seldom justifiable. It should take less than a day to classify the soils on a 400-square-mile watershed. Often, when working with a watershed in familiar territory, the hydrologist needs little more than a check on his own estimates of the groupings.

Determining Areal Extents

Precise measurement of soil-group areas, such as by planimetering soil areas on maps or weighing map cuttings, is seldom necessary for hydrologic purposes. The maximum detail should not go beyond that illustrated in figure 7.1: in a the individual soils in a hydrologic unit are shown on a sketch map; in b the soils are classified into groups; in c a grid (or "dot counter") is placed over the map and the number of grid intersections falling on each group is counted and tabulated; in d is shown the tabulation and a typical computation of a group percentage. Simplified versions of this procedure are generally used in practice.

Number of Soil Groups to be Used

Often one or two soil groups predominate in a watershed, others covering only a small part. Whether the small groups should be combined with the predominate ones depends on their classifications. For example, a hydrologic unit with 90 percent of its soils in the A group and 10 percent in the D will have most of its storm runoff coming from the D soils and putting all soils into the A groups will cause a serious under-estimation of runoff. If the groups are more nearly alike (A and B, B and C, or C and D) the under- or over-estimation may not be as serious but a test may be necessary to show this. Rather than test each case, follow the rule that two groups are combined only if one of them covers less than about 3 percent of the hydrologic unit. Impervious surfaces should always be handled separately because they produce runoff even if there is none from D soils.

Subgroups

If subgroups are used, the runoff curve numbers (CN) for them can be determined by linear interpolation on table 9.1 or, more elaborately, by the method of the following example.

Example 7.1.--A soil is to be classified in a subgroup falling midway between groups B and C. The land uses are "Row crops, straight-row, good rotation" and "Legumes, straight-row, good rotation" (see table 9.1). Determine the CN for the subgroup.

1. Use table 9.1 to find the CN for each of the four soil groups and two land uses. The results are:

Land uses	Soil groups			
	A	B	C	D
Row crops, straight-row, good rotation	67	78	86	89
Legumes, straight-row, good rotation	58	72	81	85

2. Plot the four CN for each land use as shown in figure 7.2, using each CN as the midpoint of a soil group, and draw a curve through the points. Each land use has its own curve.

3. Interpolate on the group scale and find the CN for each land use. For this example the subgroup is midway between the B and C groups so that the CN is 82 for the row crop and 77 for the legume. Linear interpolation on table 9.1 gives 81.5 and 76.5, respectively, which are rounded to 82 and 76.

The subgroup in example 7.1 can be designated the B- or C+ subgroup. More elaborate classifications (B_1, B_2, B_3, etc.) are not justified unless the soil classifications were made using rainfall-runoff data.

Reclassification of a Soil

Some of the soils in table 7.1 are in the D group because of a high water table that creates a drainage problem. Once these soils are effectively drained they can be placed in an alphabetically higher group. They can be classified locally on a case by case basis.

When there is a need to reclassify a soil on the basis of additional data, the SCS State soil scientist should submit the case for consideration to the soil correlator for that area.

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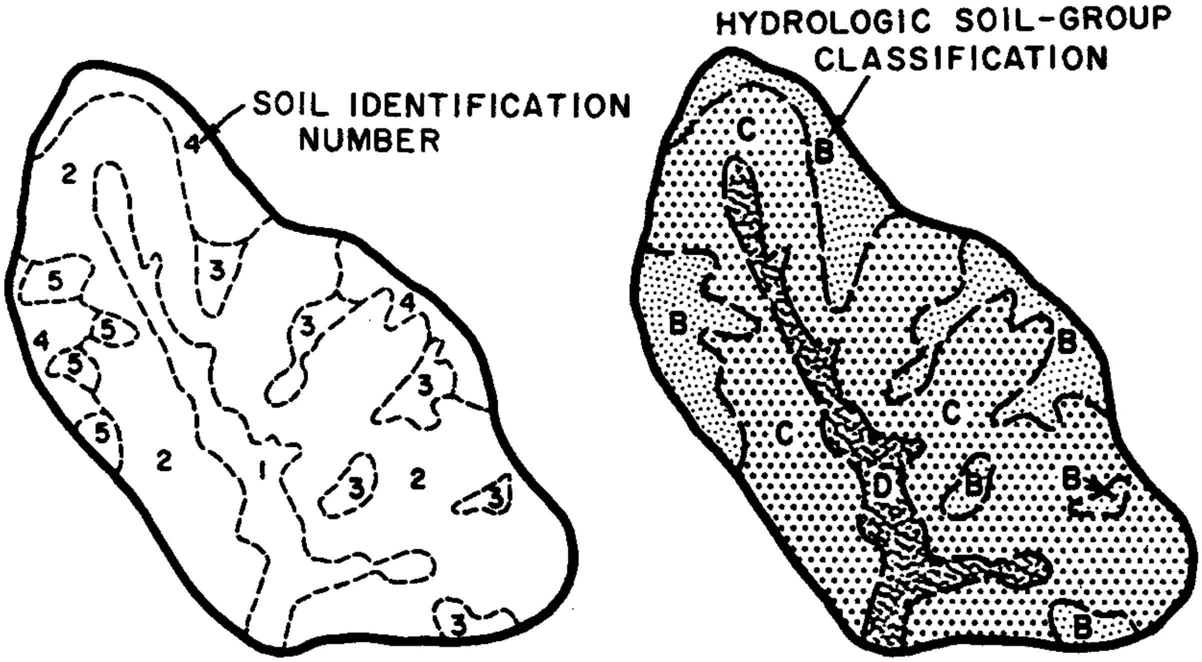
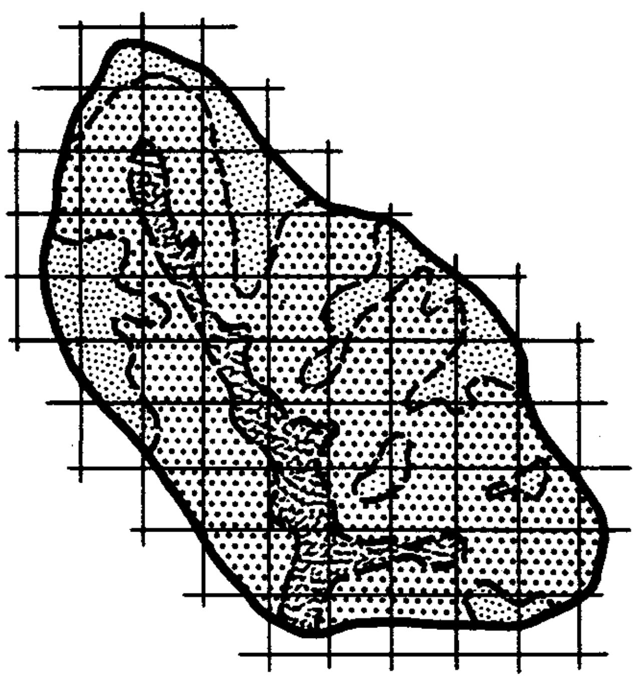
Notice Pages 7.6 to 7.38 contained an outdated hydrologic soils listing and have been deleted. The new hydrologic soils listing is a separate pdf file.



(a) DETAILED SOILS MAP (b) HYDROLOGIC SOIL GROUP MAP



(c) GRID ON SOIL GROUP MAP

SOIL GROUP	NUMBER GRID INTERSECTIONS	PERCENT
B	12	23*
C	32	63
D	7	14
TOTAL	51	100

* PERCENT FOR B:

$$(100)\frac{12}{51} = \underline{\underline{23}}$$

(d) COMPUTATIONS

Figure 7.1.--Steps in determining percentages of soil groups.

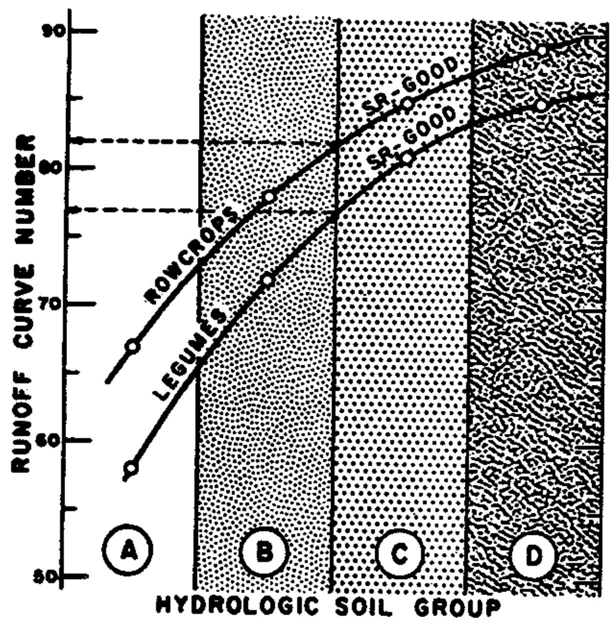


Figure 7.2.--Type of plotting used in estimating runoff curve numbers for soil subgroups. Dashed lines show results for example 7.1.